APPENDIX B

MODEL OF A CANTILEVER WITH THREE STIF 45 ELEMENTS

Accuracy of using one layer, six STIF 45 elements to model each wall of the coil is tested by modeling a cantilever beam with three STIF 45 elements, as shown in Fig. B-1. Element dimensions are taken as 1x1x1 in. and 1000 lbs. of concentrated load at each node of the cantilever tip surface is considered. Modulus of elasticity E and Poisson's ratio ν are taken as 30000 psi and 0.3 respectively. The bending stress at the middle of the top surface of center element is obtained as 36000 psi from the finite element model. This value is the same as that obtained from the beam theory. Finite element and beam theory tip deflections are obtained as 0.0151 and 0.0144 in. respectively. Satisfactory behavior of STIF 45 elements in the cantilever model indicates that "overall" stress distribution obtained from the coil analysis is reasonably accurate for design purposes.

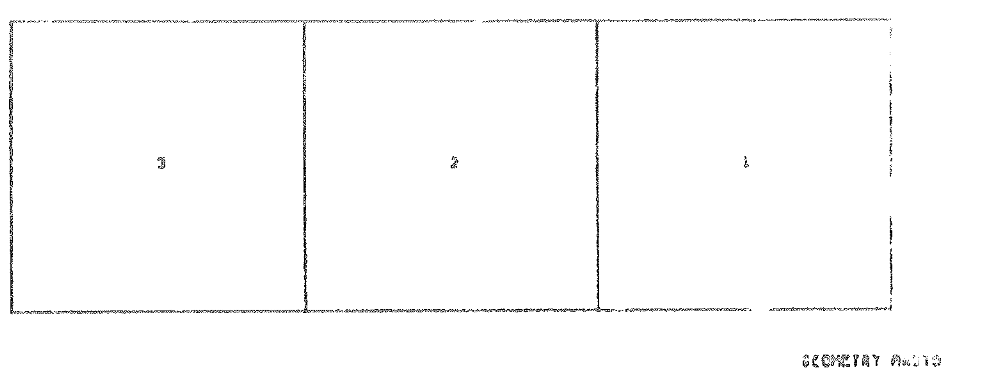


Figure B-1. Side View of the Cantilever Beam Model

ADDENDUM II

This Addendum is for reporting the results obtained from the additional analysis performed per Option 1 of our proposal dated May 26, 1981.

Analysis assumptions and the finite element model are the same as that used in our initial report. The following three runs are performed in this phase of the project:

1. A separate analysis run for a sinusoidal load, $P_r = 300 \sin\theta$ psi, applied to the outer wall per Mr. Craddock's letter of June 10, 1981, is performed. In this case, the boundary conditions are changed to represent the anti-symmetric behavior. Outer surface hoop and bending stresses are shown in Figs. II-1 and II-2 respectively.

2. Three load cases presented in the initial report are combined as one load without changing the initial model and boundary conditions. Surface hoop and bending stresses are shown in Figs. II-3 and II-4 respectively.

3. Stresses obtained for Sinusoidal pressure and combined loads are superimposed in the last run. Outer surface hoop and bending stresses are presented in Figs. II-5 and II-6 respectively.

Von Mises stresses greater than 30,000 psi are scanned in all above runs and they are included in the ANSYS output submitted with this Addendum.

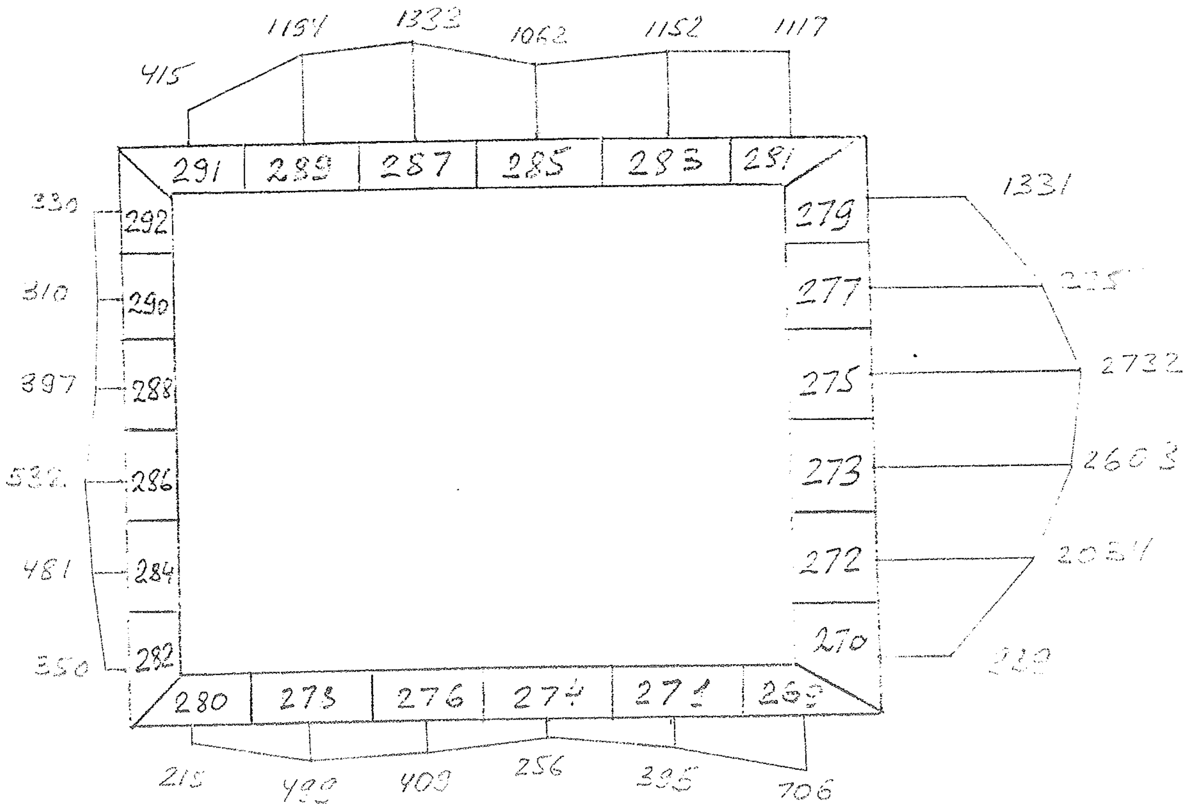


Fig. II-1

Outer Surface Hoop Stress
Vertical Radial Load
$P_r = 300 \sin\theta$

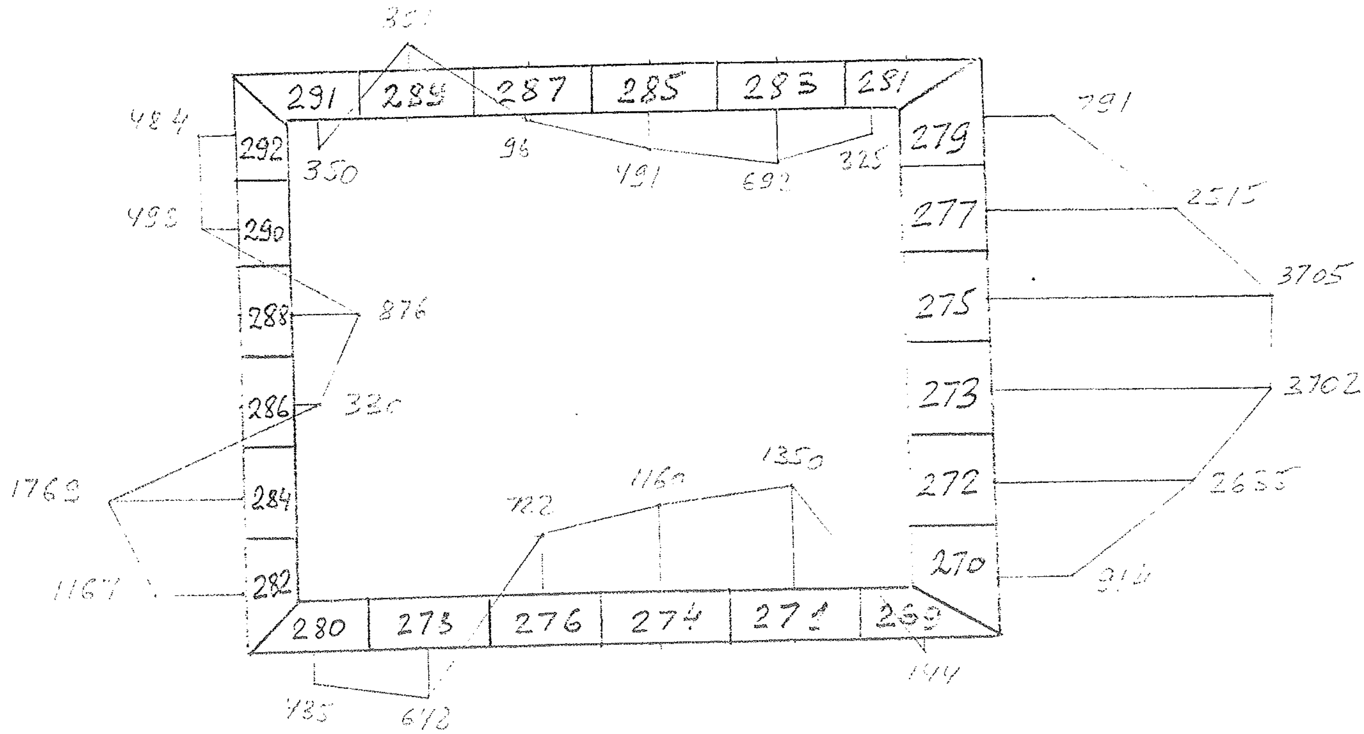


Fig. II-2

Outer Surface Bending Stress

$P_r = 300 \sin\theta$

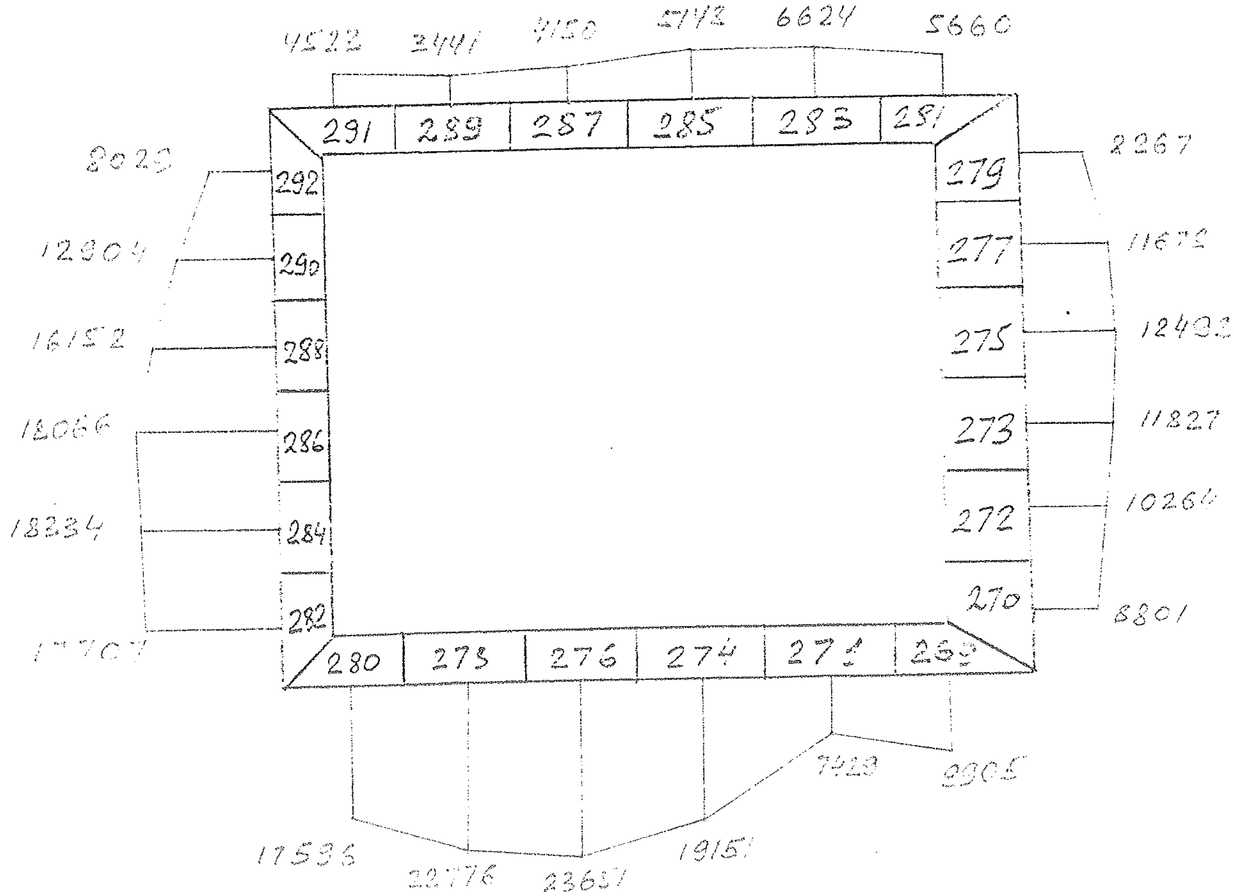


Fig. II-3

Hoop Stresses
Combination of Load Cases 1, 2, 3
900 psi radial outward pressure
on O.D and I.D plus axial loading

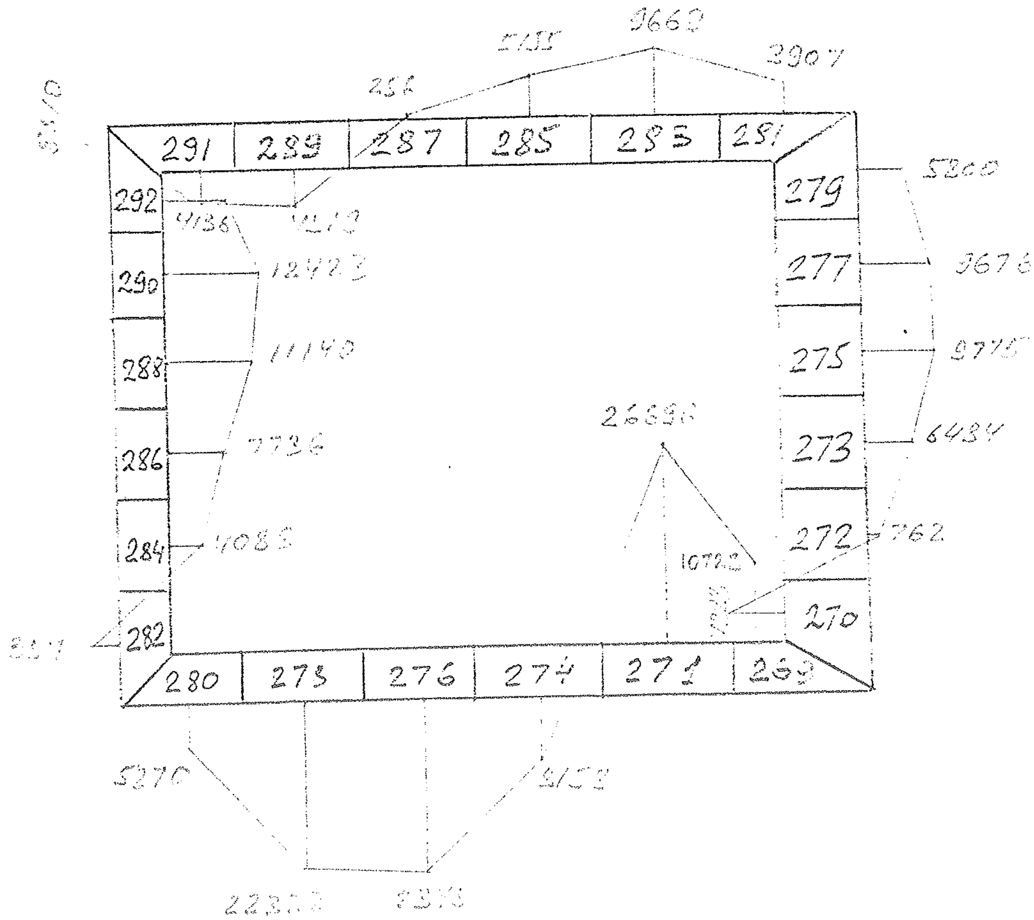


Fig. II-4

Combination of Load Cases 1, 2, and 3
Bending Stresses

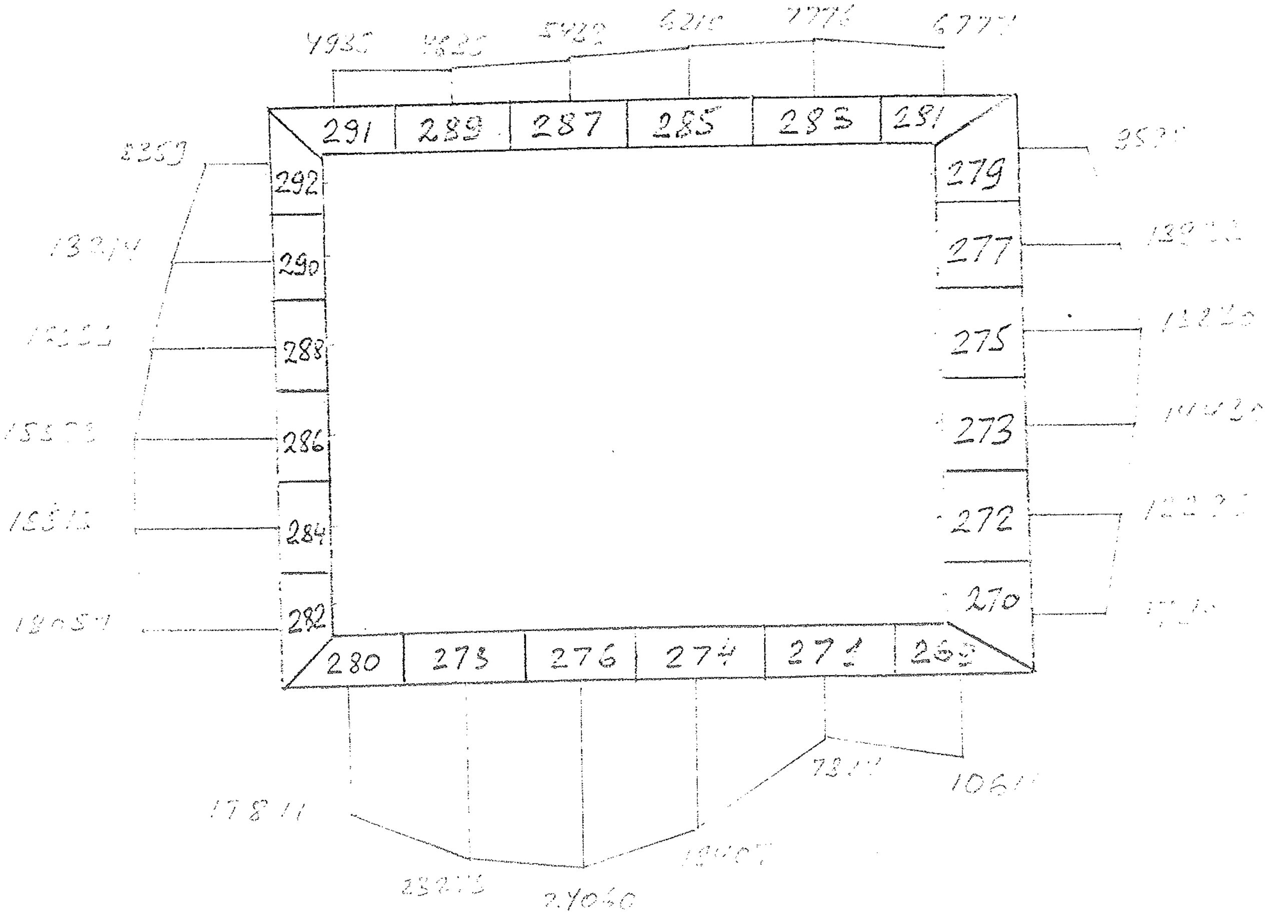


Fig. II-5

All Loads Combined
Hoop Stresses

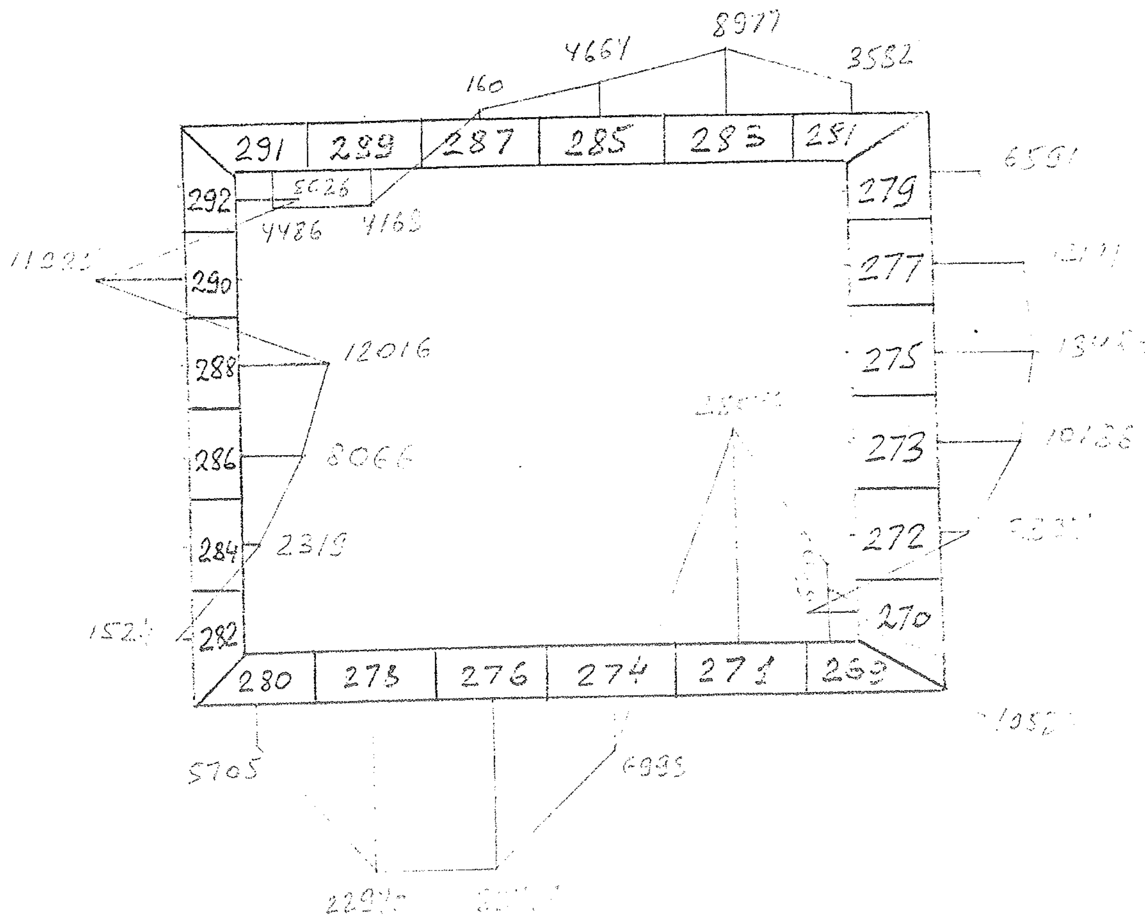
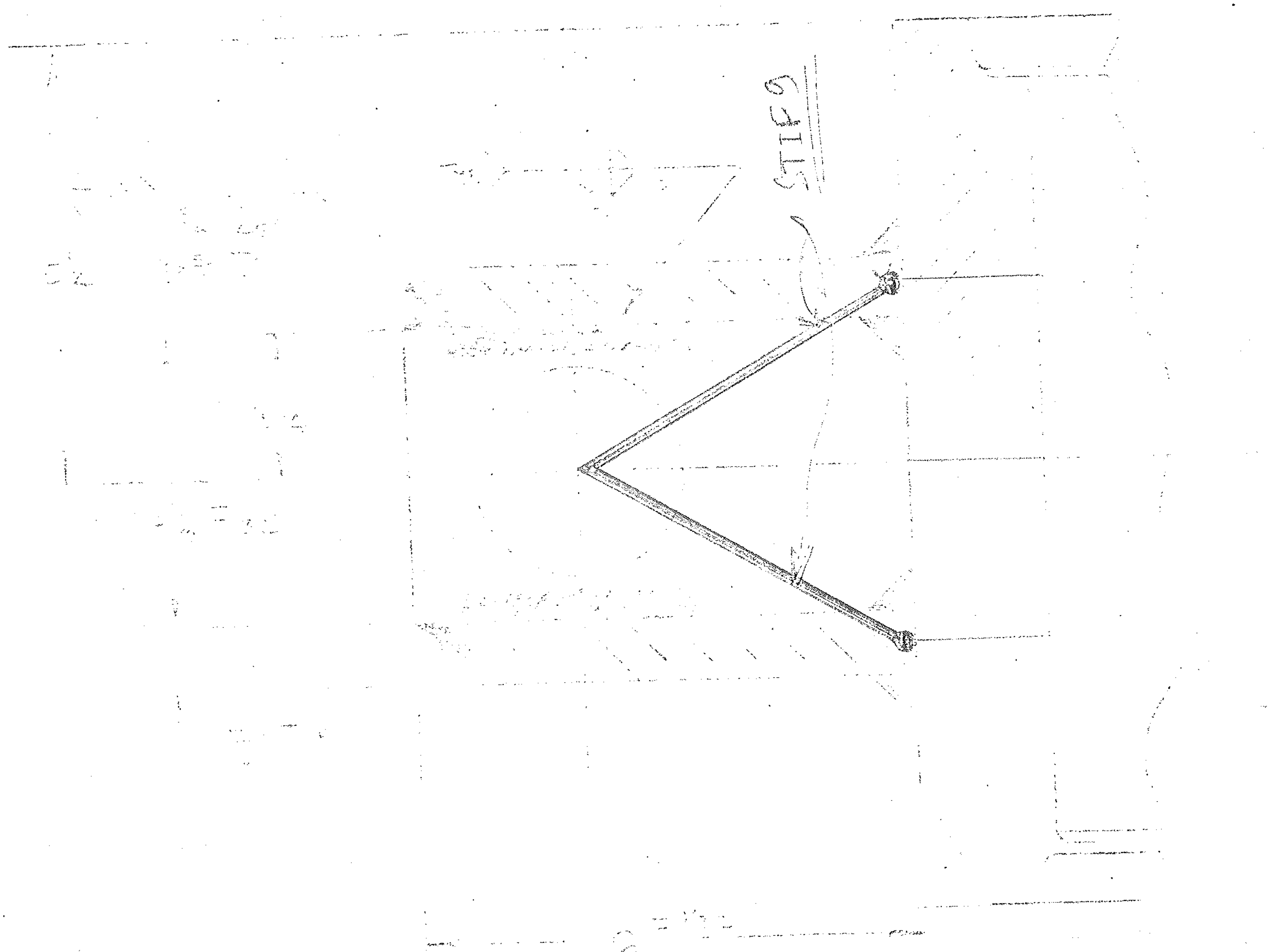


Fig. II-6

All load cases combined
Bending Stresses.

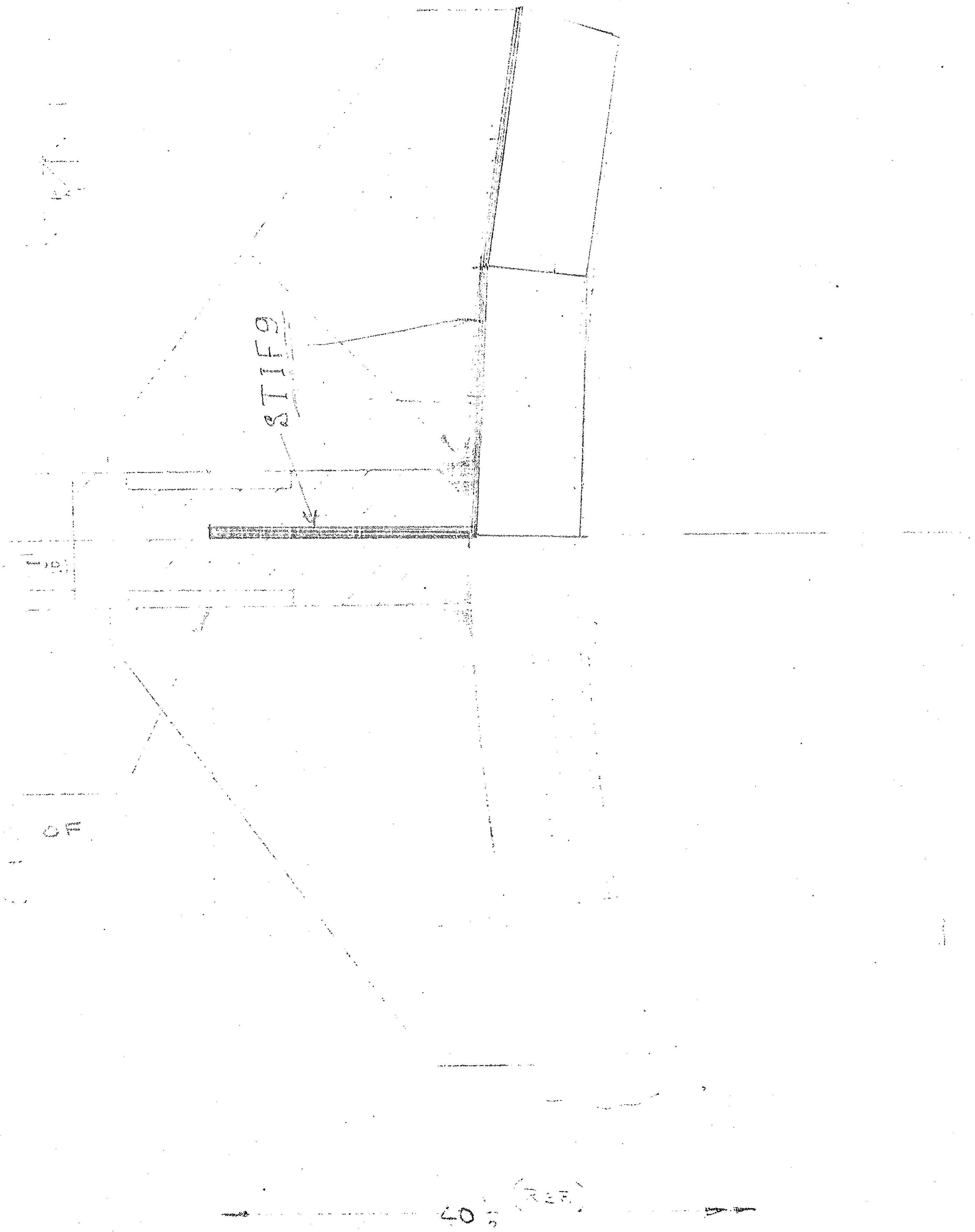
DETAIL C

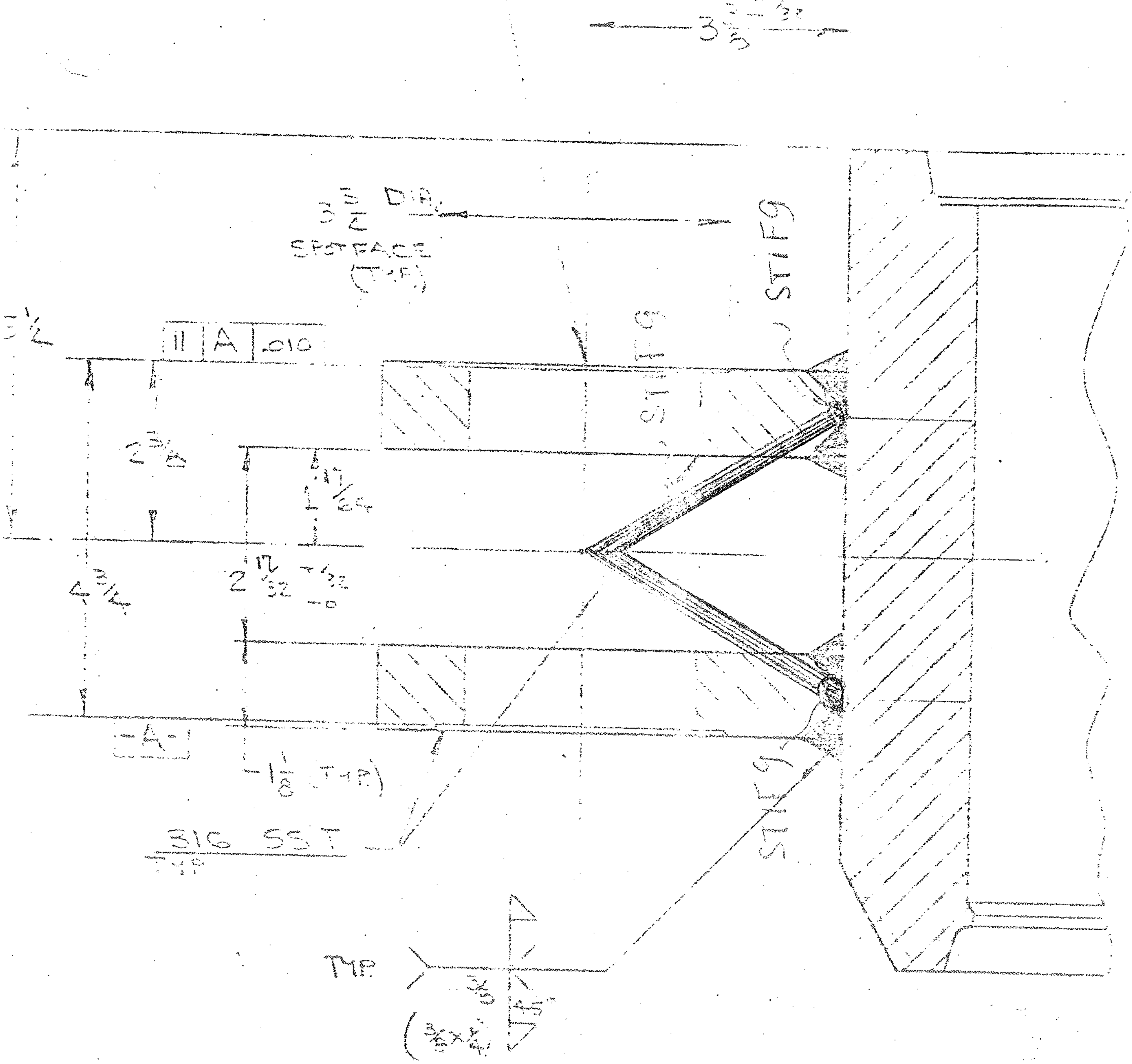
AD-1A



DETAIL C
SCALE ½

DETAIL C





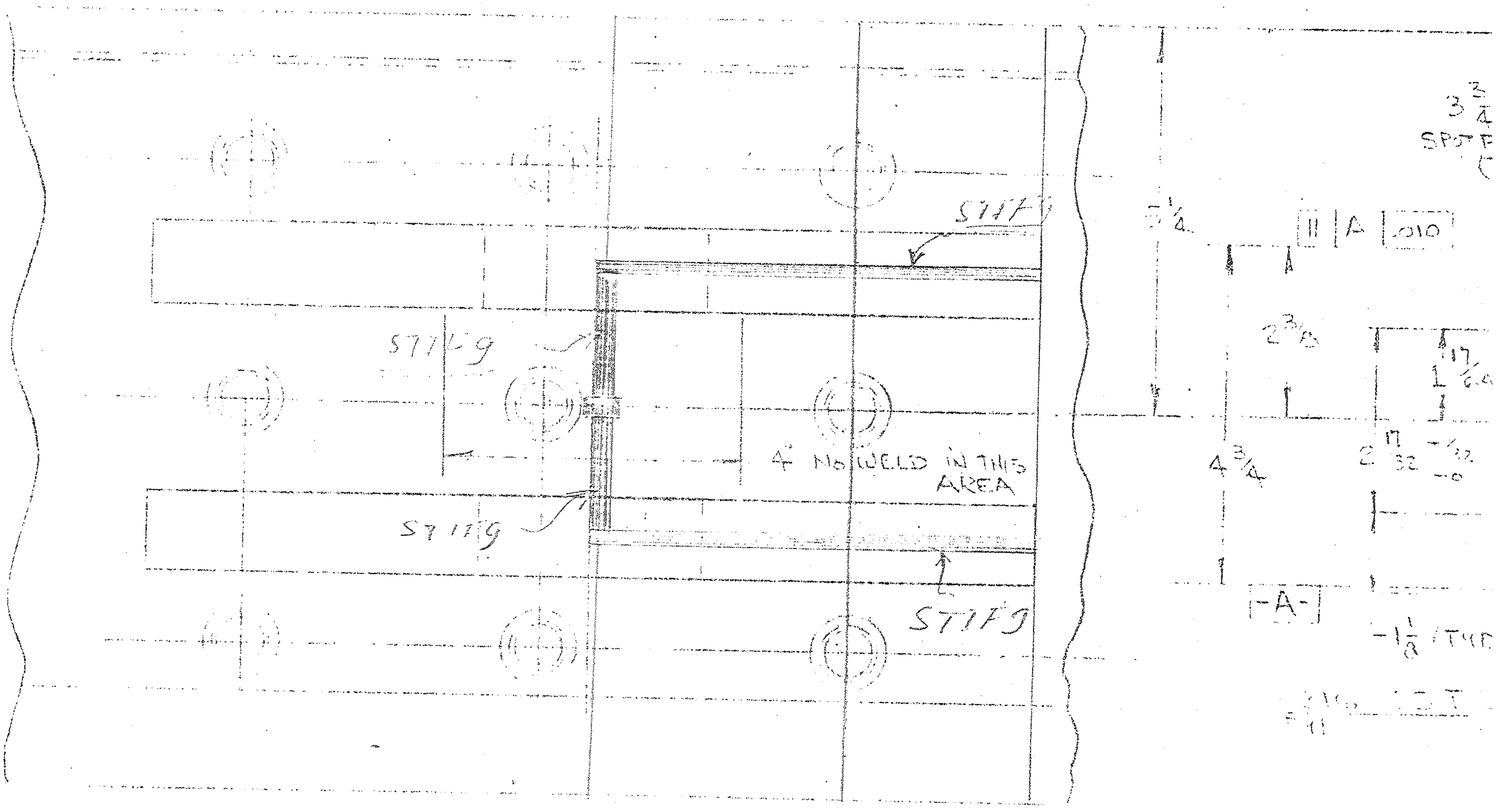
AIL B
CALE 1/2

DETAIL B

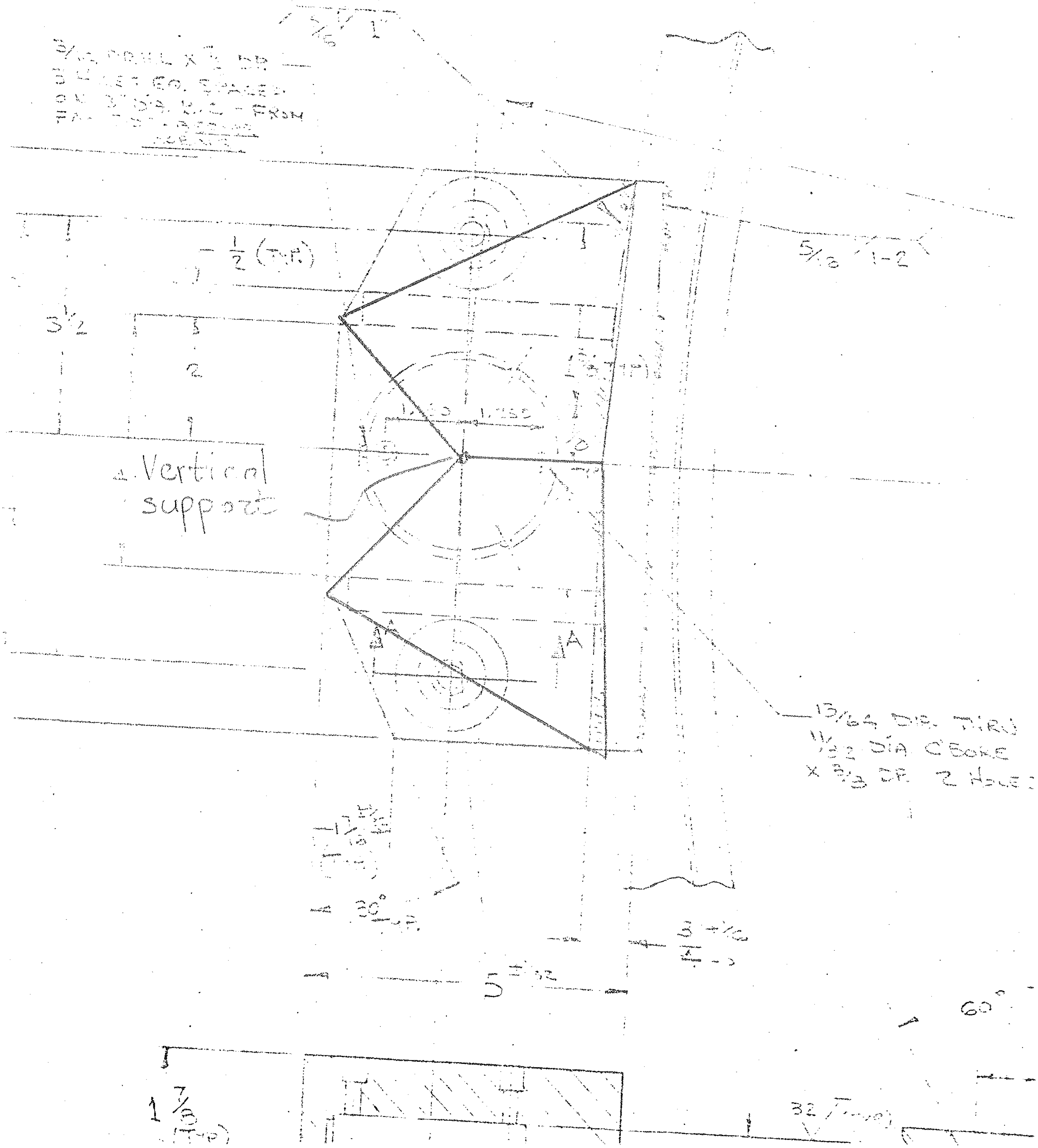
AD-2A

DETAIL B

AD-2B



DETAIL A


1/2 (TYP.)
3 1/2
2
Vertical support
5/8 1-2
13/64 DIA. THRU
11/32 DIA C'BORE
A
A
30°
5
60°
1 7/8
(TYP)

QW-482 SUGGESTED FORMAT FOR WELDING PROCEDURE SPECIFICATION (WPS)
(See QW-201.1, Section IX, ASME Boiler and Pressure Vessel Code)

Company Name Fermi Nat'l Accelerator Lab. By: James Forster
Welding Procedure Specification No. ES155002 Date 10/8/81 Supporting PQR No.(s) 811015
Revision No. ______ Date ______
Welding Process(es) GTAW, SMAW Type(s) MANUAL
(Automatic, Manual, Machine, or Semi-Auto.)

JOINTS (QW-402) — Details

Joint Design U Groove V16 gap 1/16 land
Backing (Yes) ______ (No) no
Backing Material (Type) -

Sketches, Production Drawings, Weld Symbols or Written Description should show the general arrangement of the parts to be welded. Where applicable, the root spacing and the details of weld groove may be specified.

(At the option of the Mfgr., sketches may be attached to illustrate joint design, weld layers and bead sequence, e.g. for notch toughness procedures, for multiple process procedures, etc.)

***BASE METALS (QW-403)**

P-No. 8 Group No. 1 to P-No. 8 Group No. 1
OR
Specification type and grade 304 SA240
to Specification type and grade 304 SA240
OR
Chem. Analysis and Mech. Prop. ______
to Chem. Analysis and Mech. Prop. ______
Thickness Range:
Base Metal: Groove 3/16 to 1½ Fillet ______
Deposited Weld Metal
Pipe Dia. Range: Groove ______ Fillet ______
Other ______

***FILLER METALS (QW-404)**

F-No. 4 Other 4 root pass
A-No. 8 Other 8
Spec. No. (SFA) ______
AWS No. (Class) 5.4 69 E316L-15 ER316L (root pass)
Size of filler metals ______
(Electrode, Cold Wire, Hot Wire, etc.)
Electrode-Flux (Class) E316L-15 Lime
Flux Trade Name ______
Consumable Insert ______

*Each base metal-filler metal combination should be recorded individually.

POSITIONS (QW-405)
Position(s) of Groove: Flat 1G
Welding Progression: Up ____ Down ____
Position(s) of Fillet: flat

PREHEAT (QW-406)
Preheat Temp. Min. ____
Interpass Temp. Max. ____
Preheat Maintenance ____
(Continuous or special heating where applicable should be recorded)

POSTWELD HEAT TREATMENT (QW-407)
Temperature Range: Room temp.
Time Range ____

GAS (QW-408)
Shielding Gas(es): Argon 100%
Percent Composition (mixtures): 100
Flow Rate: 20
Gas Backing: 20
Trailing Shielding Gas Composition: Argon

ELECTRICAL CHARACTERISTICS (QW-409)
Current AC or DC: DC Polarity: Straight (GTAW) Reverse SMAW
Amps (Range) ____ Volts (Range) ____
(Amps and volts range should be recorded for each electrode size, position, and thickness, etc. This information may be listed in a tabular form similar to that shown below.)
Tungsten Electrode Size and Type: 3/32 Dia. 2% Thoriated
(Pure Tungsten, 2% Thoriated, etc.)
Mode of Metal Transfer for GMAW: -
(Spray arc, short circuiting arc, etc.)
Electrode Wire feed speed range: -

TECHNIQUE (QW-410)
String or Weave Bead: String
Orifice or Gas Cup Size: 6 #
Initial and Interpass Cleaning (Brushing, Grinding, etc.): Brushing
Method of Back Gouging: -
Oscillation: -
Contact Tube to Work Distance: -
Multiple or Single Pass (per side): Multiple
Multiple or Single Electrodes: Single
Travel Speed (Range): 3 to 4 in/min.
Peening: -
Other ____

Weld Layer(s)	Process	Filler Metal Class	Filler Metal Dia.	Current Type Polar.	Current Amp Range	Volt Range	Travel Speed Range	Other (e.g., Remarks, Comments, Hot Wire Addition, Technique, Torch Angle, Etc.)
1	GTAW	ER316L	3/32	Straight	80	17	3"to 4"	
1	GTAW	"	3/32	Straight	52	18	3"to 4"	
3 - 5	SMAW	E316L-15	1/8	Straight	110	22	3"to 4"	
5 -10	SMAW	"	5/32	Straight	150	26	3"tc 4"	

PITTSBURGH TESTING LABORATORY

ESTABLISHED 1881

PITTSBURGH, PA.

Order No. CH 5396

Date Oct. 15, 1981

PQR #811015

PHYSICAL TEST REPORT OF WELDING PROCEDURE QUALIFICATION TESTS

Client FERMI NATIONAL ACCELERATOR LABORATORY

Specification No. ES155002 — Date

Welding Process SMAW GTAW root pass — Manual or Machine Manual

Material Specification SA240 Type 304 to 304 of Group No. 8 to Group No. 8

Thickness (if pipe, diameter and wall thickness) 3/4"

Thickness Range this test qualifies 3/16" to 1½"

Filler Metal Classification E316L-15

ER316L root

Weld Metal Analysis No. A- 8 (ASME Sec. 9 only)

For oxyacetylene welding – State if Filler Metal is silicon or aluminum killed.

Flux or Atmosphere

Flux Trade Name or Composition

Inert Gas Composition Argon

Trade Name — Flow Rate

Is Backing Strip used? No — Preheat Temp. Range

Postheat Treatment None

Position Flat 1G

(For plate, flat, horizontal, vertical, or overhead; if vertical, state whether up or down, For pipe: Axis of pipe vertical, horizontal fixed, or horizontal rolled).

Welding Procedure

Single or Multiple Pass Multiple

Single or Multiple Arc Single

– For Information Only –

Filler Wire – Diameter 1/8" & 5/32"

Trade Name KRYOKAY 316L

Type of Backing None

Welding Techniques

Joint Dimensions Accord with

amps 130 for 5/32" volts inches per min.

Above information by PTL ☐ Client ☒ Other

Preparation of specimens witnessed by PTL Yes ☐ No ☒

Reduced Section Tensile Test

SPECIMEN NO.	DIMENSIONS-INCHES WIDTH	THICKNESS	AREA SQ. IN.	ULTIMATE TOTAL LOAD, LBS.	ULTIMATE UNIT STRESS, PSI	CHARACTER OF FAILURE AND LOCATION
1	1.496	.734	1.098	86500	78800	Weld metal
2	1.498	.773	1.158	92750	80100	Parent metal

Guided Bend Tests

TYPE AND FIGURE NO.	RESULT	TYPE AND FIGURE NO.	RESULT
Side 1	Pass	Side 3	Pass
Side 2	Pass	Side 4	Pass

Welder's Name Ron Threadgill — Clock No. 5023 — Stamp No.

Did the welder by virtue of these tests meet welder performance requirements? ☒ Yes ☐ No

Test witnessed by [signature] — Test No. 9275

per

Results of tests (do) (do not) meet requirements of

ASME Sec. IX

PITTSBURGH TESTING LABORATORY

By [signature]

David A. Dunn, Chicago District

09

PITTSBURGH TESTING LABORATORY

ESTABLISHED 1881

PITTSBURGH, PA.

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FORM 1366

Job No. CH 5396

Client's No.

Report No. Lab #9275

Date 10-22-81

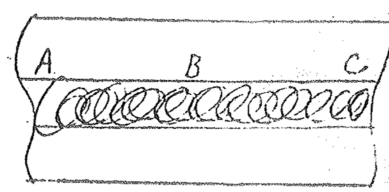
RADIOGRAPHIC INSPECTION REPORT

CLIENT Fermi National Accelerator Lab P.O. Box 500 Batavia, IL 60510	DRAWING NO.	SHOP ORDER
	PART NO.	DATE RADIOGRAPHED
PROJECT	SERIAL NO.	
STAGE OF FABRICATION	HEAT NO.	
SPEC. NO. ASME Sec IX / STANDARD	TYPE OF MATERIAL SS	SOURCE OF RADIATION IR 192

Weldment	X
Casting	
Other	
Single Wall	X
Double Wall	
Mtl. Thickness	3/4 + Cr.
Film to Source	22"
Exposure Time	7 min.
Kilovolts	70 Ci
Milliamperes	
Screens	010Pb
Filters	
Pentrameter	20
Sensitivity	2T
Film Type	T Film

FILM IDENTIFICATION	Accept	Reject	Surface Indications	Porosity	Slag Inclusions	Cracks	Incomplete Fusion	Inadequate Penetration	Tungsten Inclusions	Undercut	Burn Through	Gas and Blow Holes	Sand Inclusions	Internal Shrinkage	Hot Tears	Unfused Chaplets	Internal Chills	Cold Shuts	REMARKS
Welder: Ron Threadgill																			
SMAW/GTAW 1G																			
A-B-C	X																		

WELD MAP



2 Films
4½ x 17"

diographer: T. George, Level II

terpreter: T. George, Level II

viewer: .... Date

PITTSBURGH TESTING LABORATORY

CERTIFICATE OF INSPECTION

CONAM INSPECTION Inc.
1245 West Norwood
Itasca, Illinois 60143
(312)773-9400

Report No. ____

Date 12-15-81

Customer: FERMI NATIONAL ACCELERATOR LAB

Cust. P.O. No. 28594

Attn. Mr. Dick Mau

Job Order No. CH-13348

Street Address P.O. Box 500

City & State Batavia, IL 60510

☐ PENETRANT ____ ☐ MAGNETIC PARTICLE ____

☒ ULTRASONIC Contact ☐ EDDY CURRENT ____

Material SS Weldment (See Drawing No. 2771-MD-56365)

Accpt. Std. 1. Absense of Volumetric Indications equalling indication from root/ land area.
2. Absense of crack like indications.

Spec. Searching for cracks

Test Equipt. Krautkramer USM-2

Tech. Data Couplant - Echogel (certified)

.5" x .5" x 2.25 MHz. x 69° Transducer, .5" dia. x 5 MHz. Transducer

Set up Data Ref. sensitivity = AWS, DSC Block 1/32" groove + 6 db's = Twice AWS sensitivity
62 db's + 6 db's = 68 db's Ref.

TEST RESULTS

(See U.T. Technic Plot)

On first examining the weld from position "A" is was found that there was an almost continuous opening in the root land area (not full penetration). This was later confirmed by doing a 0° exam from positions "B" and "C".

While trying to determine what reference standard and criteria to use in evaluating this weld, the customer stated that they could accept the condition of the root and they were more concerned with cracking in the remaining volumn of the weld.

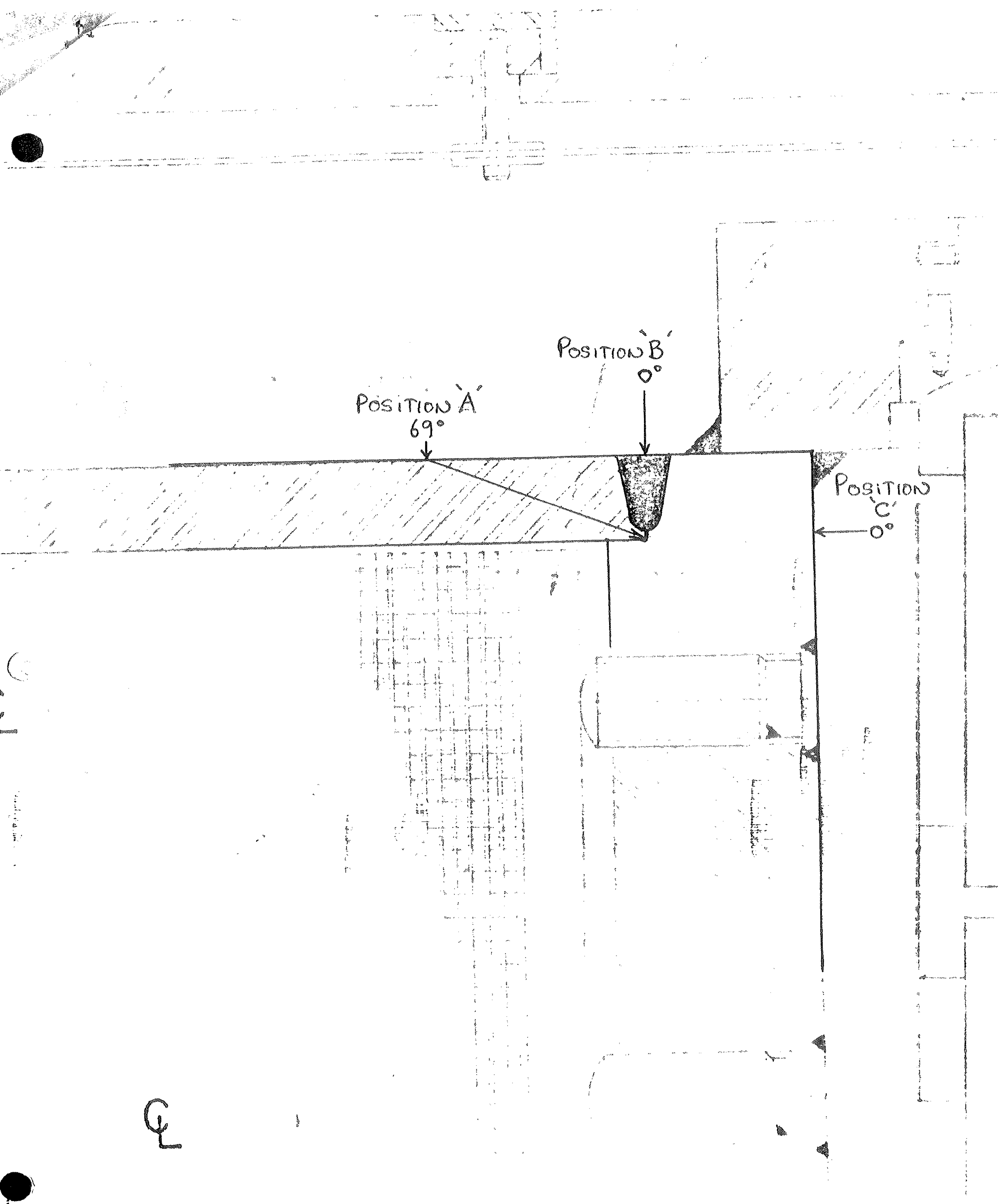
Calibration was to an AWS Calibration Reflector (DSC Block), and an additional 6 db's was added for reference. With this calibration the root opening in general reached 80% FSH. The rest of the weld had no defects exceeding 20% FSH, and no crack like indications were noted.

Ronald E. Wilson

Ronald E. Wilson, Level II

AUTOMATION INDUSTRIES, INC. — INSPECTOR — OBSERVER/RECEIVED BY

FORM SL MGMT. 8;7-67



'UT TECHNIC PLOT'